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SCIENCE TRENDS

HIGHLIGHTS

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Army Aviation Research Problems
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* ARMY AVIATION RESEARCH PROBLEMS

Here is the latest summary of aviation problems as compiled by the Army Transportation Research Command. Proposed solutions are sought from industry, universities, non-profit organizations and individuals. Comments, inquiries, and proposed solutions should be forwarded to:

Chief of Transportation
ATTN: Director of Research and Development
Department of the Army
Washington 25, D. C.

Note: Problem numbers are non-consecutive because of deletion of prior requirements.

□ TC - 1 -- Develop simple, more rugged rotor hub assemblies for helicopters. (Although the performance of rotating-wing vehicles has been greatly improved, present rotor hub assemblies continue to be costly and complex mechanisms. Maintenance costs and service life of these systems are matters of concern to the Army. It would be of great advantage to provide major advancements in achieving simple, lighter and more durable rotor hub assemblies for integration with future aircraft.)

□ TC - 2 -- Develop rotor systems for higher speed helicopters, greater than 200 knots. (Several factors limit the forward flight capabilities of current helicopters: high drag, power limitations, vibration levels, and rotor tip speed. Continuing development should result in improvement in the first three factors, but full benefit of these gains cannot be realized until higher rotor speeds are obtained. This development may require the use of supersonic rotor systems for very high speed vehicles. For example, the application of supersonic propellers to long-range transports has proved to be advantageous at high speeds for some configurations. New ways and means are required to increase tip speeds on rotary-wing aircraft to permit higher aircraft velocities.)

□ TC - 4 -- Develop lightweight propeller systems for V/STOL aircraft. (Nearly all of the presently developed V/STOL aircraft have heavy propeller or rotor systems. There is a need for weight reduction of these assemblies. Improvement should provide distinct performance gains for the V/STOL-type aircraft as well as reduce vibration and stress levels in the propellers themselves.)

□ TC - 13 -- Devise new techniques for the reduction of downwash and reingestion. (The downwash from lifting rotors, propellers, or jets of VTOL aircraft often creates serious operational problems. Dust and debris that are recirculated often damage power plants and other components. A dust or snow plume provides a signature for easy enemy detection. Also, the pilot's visibility is so obscured that hovering operation cannot be safety continued.

(Continued)

* ARMY AVIATION RESEARCH PROBLEMS (Continued)

The Army and other Department of Defense agencies have sponsored research that has done much to define the technical aspects of the problem. A few partial solutions have been suggested; for example, the use of lightweight landing mats that could be air-dropped. Aerodynamic approaches to reducing the magnitude of the problem are under study. Methods, equipments, or systems that will reduce or eliminate the problem are required to permit maximum exploitation of VTOL aircraft in Army field operations.)

- TC - 6 -- Develop lightweight, reliable means for transmitting power from the power source to the propulsion units. (With the development of VTOL aircraft utilizing multiple propellers and the deflected-slip-stream principle, interconnection between propellers is common practice. Problems have arisen in designing systems to transmit the power from the main power unit to the propellers. In conventional systems, which use continuous shafting for power transmission, dynamic vibrations at the resonant speeds of the shafts provide limits to power operation and produce high stresses. Any system should include fail-safe criteria to offset potential propeller governor failures. Some means should be included that would permit damaged propellers to be uncoupled and feathered. There is a joint Army-Air Force project to obtain design criteria for aircraft high-speed shafting for interconnecting single- or multiple-engine installations with varying combinations of propellers or rotors.)

- TC - 8 -- Improve high-speed reducers (transmission systems) that will be compatible for use with gas-turbine engines. (With the advent of the application of the gas-turbine engine in Army helicopters, a requirement exists for the design and development of a reliable, lightweight transmission that is more compatible with the high speed of gas-turbine engines. A review of the state-of-the-art shows that presently used planetary and lay shaft-type transmissions incur severe weight penalties in high reduction ratio areas. It is desirable to have a transmission system that is more compatible with the high speed of turboshaft units. See Problem 6.)

- TC - 17 -- Develop new methods for increasing the flight safety of vertical take-off and landing (VTOL) air vehicles. (In discussing flight safety of VTOL air vehicles, four distinct flight regimes should be considered. These are (a) take-off, (b) cruise, (c) landing, and (d) hovering. In each of the flight regimes, certain factors are critical to the safety of operation. These factors range from loss of power (especially critical during take-off, transition, landing, and hovering operations) to terrain and obstruction clearance during all regimes of flight. The requirement for low-level operations, particularly during periods of reduced visibility, emphasizes the need for greater reliability of propulsion systems and reliable means of preventing collision with terrain and/or obstructions.)

- TC - 18 -- Develop simple and improved control system for air vehicles. (Aircraft controls for Army air vehicles, particularly for rotary-wing and VTOL types, are becoming extremely complex. Considerable time is required to train and maintain proficiency of the crew with these complex systems. Excessive maintenance and expense are encountered in rigging and checking the systems for proper operation. Through new concepts of control, it appears possible to reduce pilot workload and control system complexity significantly, and simultaneously to improve handling qualities and reduce cost.)

- TC - 32 -- Develop or utilize new lightweight materials and/or techniques in Army aircraft components and structures. (New materials are constantly being developed and existing materials are being improved. The technology is advancing at an ever-increasing rate, and the results of this work must be applied to Army aircraft to accomplish the objective of lightweight, long-life components. The requirement is to incorporate newly developed materials in the design of future Army aircraft.)

* ARMY AVIATION RESEARCH PROBLEMS (Continued)

- TC - 19 -- Provide the pilot of low-flying aircraft with adequate warning of the approach of an uncontrollable flight condition. (With the increase in aircraft weights and maximum speeds, flight at low speeds below about 100 knots in many cases is a very vulnerable regime. Outside disturbances, pilot reactions, and aircraft responses may all contribute to a completely uncontrollable flight condition arising in an emergency. This is particularly true of aircraft now being developed that are capable of vertical take-off and landing, where part of the flight regime is conducted "on the backside of the power curve". Several types of warning devices have been developed and used successfully with conventional aircraft, such as the audible tone system, the colored light system, and, for general use, the stick-shaker system. These represent approaches in the right direction but will not be adequate in future operations. To provide a completely foolproof pilot warning device to increase pilot capability and confidence in all conditions of flight, much research is yet to be done.)

- TC - 22 -- Devise combustion prevention methods for use with aircraft fuel systems during emergencies. (A major contributing factor to the aircraft fatality rate is ignition and explosion of the fuel, which frequently occurs upon collision or impact. Some means must be developed for inhibiting the destructive forces inherent in aircraft fuel. The device should have the following characteristics:

  ✓ It should be capable of chemically or physically rendering the fuel inert upon impact. This it must do automatically, instantly, and positively. It must inactivate the fuel in the tanks, carburetor, and induction lines. It must do this by changing the chemical or physical characteristics of the fuel or by instantly ejecting the integral fuel system and components prior to ignition and ejection to a safe distance from the site of the accident.
  ✓ It must be designed to work only in case of an aircraft accident. It would be disastrous if the safety action were accidently triggered while the craft was in normal flight or in combat.
  ✓ It must be light in weight to minimize the necessary decrease in payload.
  ✓ It must be applicable to rotary-wing as well as to fixed-wing aircraft.
  ✓ It must provide for rapid cooling below ignition point in such components as exhaust collector rings, etc.)

- TC - 25 -- Devise more effective methods for prevention and/or removal of snow and ice from Army aircraft. (The removal of snow, ice, and/or frost from the surfaces and components of Army aircraft parked in unprotected areas under adverse climatic conditions poses serious and hazardous maintenance and operational problems. Investigation of the current state-of-the-art indicates that there are no known methods or devices for removing snow, ice, and/or frost which satisfy the peculiar requirements of Army aviation.)

- TC - 26 -- Determine means of reducing noise in Army aircraft and establish design criteria for assuring a safe noise level in future aircraft. (The internal noise level of current military aircraft adversely affects personnel to the extent that occupants are required to be almost completely dependent upon intercommunication systems; the level is often high enough to produce fatigue and hearing loss in those personnel not equipped with adequate ear protection. Also, the high external noise level serves to make the aircraft more vulnerable to enemy detection. The attenuation of noise generated by gas-turbine engines will require techniques differing from those applicable to other types of engines. The objective is to develop design criteria for Army aircraft which will provide a safe noise level either through the suppression of noise normally present or through the reduction of noise generated by the aircraft engines and other components.)

* ARMY AVIATION RESEARCH PROBLEMS (Continued)

- TC - 27 -- Develop methods for reducing, isolating, or eliminating vibration in aircraft. (Undesirable vibration has long been associated with helicopters. It now appears that the same problem may be associated with any air vehicle using large propellers, particularly if the propeller is operating at some angle of yaw. Isolation systems have been tried, but are generally heavy. Use of new materials in the rotor or propeller blades to absorb some of the vibration has been suggested, but to date it has not been successful. New or novel approaches to vibration reduction or isolation would be welcome.)

- TC - 28 -- Develop wing and body boundary layer control (BLC) design data applicable to the reduction of drag at high speed and the increase of lift at low speed. (Data now available support design of either suction BLC or blowing BLC, but not the two together without penalty. The integration of the two systems should provide appreciable simplification and weight saving. Wider use of BLC would ensue, resulting in improved operational equipment, if design data sheets covering combination systems were available in the product design phase. Other methods of effecting BLC are of interest.)

- TC - 33 -- Reduce the vulnerability of aircraft to radar detection. (In conducting front-line missions, close-support missions, or transport missions in tactical areas, Army aircraft will be subjected to enemy surveillance by all available means of detection. This surveillance will result in attack by other aircraft and missiles that will also utilize detection devices to "home in" on their targets. To permit Army aircraft to operate with maximum effectiveness, it is necessary to reduce as far as possible the likelihood of detection by enemy equipment. New means are required that will reduce or eliminate radar signatures of Army aircraft.)

- TC - 83 -- Develop large-perturbation theory applicable to aerodynamics theory. (The simplifying assumption of small disturbances that is utilized in the solution of conventional aerodynamic problems does not adequately describe the flow conditions encountered in very slow flight. Valid analysis of the aerodynamics of V/STOL flight must allow for large disturbance velocities. Such analysis leads to involved mathematical relations that may be quite difficult to solve in terms of appropriate aerodynamic coefficients. Practical solutions to such aerodynamic problems, however, are essential to the systematic development of V/STOL aircraft.

  The requirement is the development of mathematical relationships that adequately define the aerodynamic forces, moments, downwash flow patterns, and damping parameters of lifting systems operating both in uniform and in nonuniform flow fields in which the velocities normal to the flight path are not small in comparison to the flight velocity. Cornell Aeronautical Laboratories has performed work in this area under Army sponsorship.)

- TC - 84 -- Develop criteria which will permit the design of airframes for successful operation in rough terrain. (The accelerations experienced by the airframe and landing gear of aircraft operating from rough terrain may impose stresses that are beyond the design limits of the structure of existing aircraft. The requirement is to establish structural design criteria for aircraft that will be used in rough-terrain operations.)

- TC - 85 -- Develop new rough-terrain landing gear concepts for application to Army aircraft. (Current concepts for future operations utilizing Army aircraft dictate the need for landing gear that will provide the aircraft with the capability of take-off and landing over rough terrain. The requirement is to develop suitable rough-terrain landing gear adaptable to Army aircraft. A considerable amount of prior work on tracked gears and low-pressure tires has not produced a satisfactory solution. Application of the ground effect phenomenon is also being considered.)

* ARMY AVIATION RESEARCH PROBLEMS (Continued)

- TC - 86 -- Develop a solution for eliminating or reducing the static electricity on Army helicopters. (Field personnel engaging in underslung cargo operations with helicopters have been subjected to electrical shocks when attaching the cargo sling to the helicopter cargo hook. Such shocks are of a magnitude that can cause muscular spasms in the individual and render him unconscious. There is also a possibility of detonation of underslung fuels and munitons from spark contact during external transport. The requirement is to develop effective means of discharging electricity from existing and future helicopters or to find means for preventing static electricity build-up. Some progress has been achieved toward methods of dissipating static electricity build-up.)

- TC - 87 -- Develop new means to detect icing on helicopter rotor blades. (Future helicopters will be instrumented for all-weather operation, which includes the installation of deicing equipment. Ice accretion on helicopter rotor blades seriously impedes the safe operation of the helicopter. Unless the deicing equipment is turned on at take-off, the ice accumulation goes undetected until such time as there is a decrease in rotor RPM and/or severe vibrations are set up by uneven shedding of the ice, at which point it is too late to actuate deicing equipment; thus, the mission is delayed, if not ended. It is not economically feasible to turn on deicing equipment at take-off because of the unwarranted power taxation required by the electrical deicing system and/or the expenditure of the limited amount of fluid for the fluid deicing system. Therefore, helicopters, unlike fixed-wing aircraft, on which ice accretion can be readily observed, must have a special device for detecting rotor blade ice accretion and alerting the pilot to such condition. The ice detector would alert the pilot to the presence of ice so that deicing equipment could be cycled effectively and economically. The end result would be an ice detector suitable as standard equipment for all new model Army helicopters.)

- TC - 88 -- Develop means of eliminating fuel contamination during the operation of Army aircraft. (Army aircraft accidents are being caused by engine stoppage due to fuel contamination. The advent of turbine engines and the greater emphasis being applied to VTOL and STOL operations have aggravated the fuel contamination problems associated with Army aviation operations in the tactical environment. A need exists to conduct research studies and investigations into the area of eliminating fuel contamination during the operation of Army aircraft.)

- TC - 89 -- Develop improved means for helicopter rotor blade tracking. (For satisfactory operation, all blades of a helicopter should follow the same rotational path with respect to the craft. The tracking device will indicate the extent of the divergence in paths of the individual blades so that appropriate adjustments can be made to the blades to harmonize the paths. If practicable, the device will be adaptable for use with all helicopter configurations and will be able to track blades in flight. Electronic and optical blade tracking systems have been developed with some degree of success; however, these devices are complex and expensive. The requirement is to design and develop a simple, reliable means of rotor blade tracking for use in maintaining Army helicopters.)

- TC - 90 -- Develop criteria for design of supercritical-speed shafting to be used in V/STOL aircraft. (A state-of-the-art study indicated the almost universal practice of manufacturers' avoiding the use of supercritical-speed shafting. There is a need for aircraft high-speed shafting for use in interconnecting single or multiple engine installations with varying combinations of propellers or rotors. The requirement is to develop criteria for the design of supercritical-speed shafting that will enable the designer to incorporate lightweight, high-speed, low-torque systems of "interconnect" in the power train of V/STOL aircraft. See Problem 6.)

* ARMY AVIATION RESEARCH PROBLEMS (Continued)

- TC - 91 -- Develop, for use in Army air vehicles, longer lasting types of bearings that have less maintenance requirements. (A continuing requirement exists to increase the life and reliability of and to decrease maintenance requirements for ball, roller, and other types of bearings in Army vehicles. The problem involves bearings under continuous and cyclic loads and is particularly severe in the case of bearings which are oscillating under these loads.)

- TC - 92 -- Determine what power augmentation methods are feasible for various types of aircraft. (An important aspect of power augmentation is the provision of sufficient power to carry out missions of extreme overload and/or endurance where military expediency is required. Such systems may also have value in certain types of VTOL design in providing a solution to the basic inconsistency between the power required to hover and that required to cruise. An investigation of power augmentation methods must be made to determine which systems are feasible for various types of aircraft.)

- TC - 93 -- Develop wear and incipient failure detection systems for aircraft components. (Improved methods of detecting impending defects or incipient failures in aircraft components would provide greater safety assurance and better utilization of parts by obviating the requirement for replacing parts at given intervals regardless of condition. Such methods not only would reduce the number of spares required and the requirement for skilled manpower, but also would provide an increased measure of safety in those instances where a defect might cause failure of a part before its inspection or replacement period.)

- TC - 62 -- Develop methods for improving turbine fuel economy. (The over-all efficiency of aircraft power plants must be improved. In particular, methods for decreasing the specific fuel consumption of gas-turbine engines are needed. New and more sophisticated materials, particularly those of the ceramic type, are being developed for application in space technology. It is anticipated that, with this impetus, considerable improvement in materials and manufacturing processes will allow higher combustion temperatures and pressures, with a subsequent gain in specific fuel consumption. These advances, together with blade cooling, provide some indications of the gains to be made in improving over-all efficiency. Regenerative cycles, higher temperatures, and variable geometry are possible solutions; but any method of improving the over-all efficiency would be considered.)

- TC - 79 -- Develop a simple and effective means for controlling the local fog condition at any landing area that may be used by Army aircraft. (The need for operation of airborne equipment in the Army, regardless of climate and ambient conditions, requires solutions to current fogging problems. A low-powered fog-dispersing system is required that will be effective in clearing substantial areas economically. Seeding methods must be nontoxic to ground personnel and must have no corrosive effects when ingested by the airborne system's power plant. Ideally, the dispersing equipment should be small enough to be mounted on, and operated from, the aircraft as required.)

- TC - 51 -- Develop practical vehicles based on the ground effect phenomenon. (Utilization of the ground effect phenomenon permits better distribution of the total vehicle weight over the area of the vehicle planform. Ground effect vehicles show considerable promise for providing off-road transportation of men and equipment. The existing limited height of operation (H/D ratios); the lack of satisfactory control for turning, deceleration, and negotiation of slopes; and the low efficiency of engine-duct systems are some of the problems that need to be solved if the ground effect phenomenon is to be successfully utilized in what appears to be an ideal answer to the problem areas of off-road transportation, rough-terrain landing of aircraft, and amphibious supply operations.)

□ DIGITAL ASPECT SENSOR SYSTEMS: The National Aeronautics and Space Administration is studying a number of future applications of digital aspect systems, such as the type which performed successfully under difficult conditions in the Explorer X satellite. Such systems have the advantages of analog-to-digital conversion optically using a so-called "Gray code" light mask to produce a digital indication, in vehicle-fixed coordinates, of the elevation and azimuth angles of incident light from the sun. Advanced systems will be capable of operating with the sun in the daytime and the moon at night. They will also incorporate standard infra-red horizon detectors for either day or night operation.

(For further details see NASA Technical Note D-1062 available from National Aeronautics and Space Administration, 1520 H Street, N. W., ATTN: CODE BID, Washington 25, D. C.)

□ AIR SHIPMENT ENGINE STAND: The Navy has developed a new jet engine airlift stand for shipment of high priority jet engines in the 3000 to 5000 pound class. The stand is expected to replace much heavier and bulky steel containers, which were not interchangeable for shipping various engine types. The former containers also made loading and unloading through Navy side-door aircraft particularly time-consuming. The stands may also be collapsed and folded when not in use. The major saving, however, is in the 2,540 pound reduction in weight as compared with the former steel container.

(Development program directed by B. S. Hutchins, U. S. Naval Air Development Center, Johnsville, Pa.)

□ METAL FATIGUE RESEARCH: The National Bureau of Standards has found that surface application of the liquid, dodecyl alcohol, can significantly reduce the rate of fatigue crack propagation through metal specimens. There is, as of now, no completely satisfactory explanation for this effect, which was found in such metals as steel, stainless steel, aluminum and a copper-beryllium alloy.

(For further details on the "Effect of dodecyl alcohol on fatigue crack propagation" write National Bureau of Standards, Office of Technical Information, Washington 25, D. C.)

□ FUZED FIBER OPTIC PLATES: The Army has developed fuzed fiber optic plates said to be suitable for use as coupling elements in image tubes. A one-inch diameter plate is made up of approximately 15 million individual glass fibers fuzed into a solid piece, with "suitable" optical insulation between fibers. Tests indicate these plates are capable of transferring an image from one side of the piece through the glass channels to the other side, where the image is reformed. Results are said to be high in resolution and contrast with "negligible" distortion. Future development includes fiber optic image inverters, translators and magnifiers for use in microminiature image intensification devices.

(Development by Warfare Vision Branch, U. S. Army Engineer Research and Development Laboratories, Ft. Belvoir, Va.)

□ JOINING ALUMINUM TO STAINLESS STEEL: Studies for the Atomic Energy Commission have led to development of an improved method which makes it possible to join aluminum to stainless steel by soldering without the use of a flux, and with a high-strength bond. The process is said to eliminate many of the disadvantages and difficulties of prior techniques. Neither distortion of the pieces to be joined, nor corrosion and destruction of the joint is said to occur.

(Details of this process, developed at the Hanford Atomic Products Operation, Richland, Washington are available in Report 68789 available through AEC Channels or at 50 cents from OTS, U. S. Department of Commerce, Washington 25, D. C.)

PUBLICATION CHECKLIST

- ☐ COAL RESEARCH ORGANIZATIONS, an excellent worldwide directory of organizations and publications concerned with the various aspects of coal research -- a program which is now beginning to receive heavy financial support from the U. S. Government. 64 Pages. Single Copies Free. (Write Publications-Distribution Office, U. S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. for Information Circular No. 8008)

- ☐ RECENT DEVELOPMENTS IN METALS JOINING, a brief review of information for the period April to July, 1961, covering plasma welding, explosive welding, electroslag welding equipment and adhesive bonding. 5 Pages. Single copies free to Government agencies, their contractors, subcontractors and suppliers. (Write Defense Metals Information Center, Battelle Memorial Institute, Columbus 1, Ohio for DMIC Memorandum No. 125)

- ☐ WORLD SURVEY OF ELECTRIC MOTORS, a study of the period 1955-59 designed to indicate the potential markets throughout the world. Covers production, consumption and foreign trade. 82 Pages. 35 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for "World Survey of Electric Motors, 1955-1959")

- ☐ RADIATION USES IN SCIENCE AND INDUSTRY, an Atomic Energy Commission survey for engineers, scientists and management of many of the nonpower uses of atomic energy, with the exception of medical applications. A major handbook for science and industry. 420 Pages. $2.50. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. regarding "Radiation Uses in Industry and Science")

- ☐ REACTOR SAFETY, a compilation of references to 741 unclassified reports on reactor systems, materials and operation, with the emphasis on safety factors. 76 Pages. (Report TID-3073 available through AEC channels or at $1.75 from OTS, U. S. Department of Commerce, Washington 25, D. C.)

- ☐ AWARDS OF FELLOWSHIPS AND SCHOLARSHIPS, the transcript of testimony, statements and exhibits relating to the so-called "loyalty oath" issue in National Science Foundation awards. 247 Pages. Single Copies Free. (Write Committee on Science and Astronautics, New House Office Building, Washington 25, D. C. for Hearing No. 16, H.R. 7806)

- ☐ U.K. CHEMICAL RESEARCH, the fact-filled annual report for 1960 of Britain's National Chemical Laboratory. 70 Pages. 81 Cents. (Write British Information Services, Rockefeller Plaza, New York, N. Y. for "Report of the National Chemical Laboratory, 1960")

- ☐ NUCLEAR INSTRUMENTATION, a compilation of 1,728 references dealing with a broad range of research in the design, construction and application of instruments used in radioactive environments. 149 Pages. (Report TID 3550 Revision No. 1 available through AEC channels or at $2.75 from OTS, U. S. Department of Commerce, Washington 25, D. C.)

- ☐ EXPLORER VII, a mammoth report on virtually all phases of this earth satellite from design through research findings. Includes enough blueprints to "do it yourself". 356 Pages. Single Copies Free. (Write National Aeronautics and Space Administration, Attn: CODE BID, Washington 25, D. C. for NASA Technical Note D-608)

- ☐ LABORATORY SEPARATION OF MINERALS, a review of the physical properties and specific gravity ranges of various liquids and salt solutions used for laboratory sink-float separations of rocks and minerals. Also describes test equipment and techniques. 14 Pages. Single Copies Free. (Write Publication-Distribution Office, U. S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. for Information Circular No. 8007)